Biomass assessment for power generation in Katigorah block, Cachar district, Assam

Prepared for Assam Science Technology and Environment Council
Guwahati, Assam

TERI Project Report No 2000 NE 62

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Contents

Taluka at a glance

Location	Cachar dıstrıct, Assam (24° 22' N to 25° 8' N latıtude and 92° 24' E to 93° 15' E longıtude)
Physiography and climate	Located ın the Barak-Surma-Meghna Plaın and ıs a predomınantly alluvıal plaın area It ıs draıned by Barak rıver and ıts tııbutaııes Characterısed by the presence of numerous swamps Maxımum temperatures reach about 32^0 C wıth hıgh humıdıty levels The annual precıpıtatıon ın the dıstııct ıs moıe than 200 cm
Demography	Populatıon(1991 Census) 70 862 (Male 53 20%, Female 46 79%) Scheduled Castes 20 610 (Male 52 26%, Female 47 73%) Lıteracy rate 53 53% (Male 31 92%, Female 21 6%)
Infrastructure facilities	Connectıvıty wıth the dıstrıct HQs Metalled road (29 km) Vıllages ın the block are connected wıth faır weather roads Only 20% of the vıllages have access to metalled roads No of electrıfied vıllages 34
Land-use	Total geographıcal aıea 14 358 ha Net cropped area 7 664 5 ha Grazıng land 24 ha Cultıvable waste 291 25 ha Uncultıvable land 284 ha Flood prone area 3 700 ha Drought prone area 668 ha
Agriculture	Major crop Paddy Mınor crops Mustard, Black gram, peas, *arhar*
Livestock	Cattle, buffalo poultry, goat, etc Total lıvestock populatıon 141 706
Forests	None recorded
Industry	Rıce mılls, bamboo splıttıng unıts, oıl expellıng, weavıng, and handicrafts (cane, bamboo)
Biomass generation	Woody bıomass 40 803 84 t/year Crop resıdue 22 436 86 t/year

Biomass consumption	Wood 44 325 6 t/year, Crop residue 19 963 08 t/year
Biomass surplus	Woody biomass None Crop residue 2 473 78 t/y
Biomass available for power generation	Crop residue 1 979 02 t/y (after discounting 20% processing loss)
Suggested biomass conversion technology	Crop residues based gasifier system (dual fuel mode)
Potential power generation	3 614 65 kWh/day
Potential installed capacity	150 61 kW (considering generation for 24 hours per day) 602 44 kW (considering generation for 6 hours per day)
Plan of action	Three different capacities of crop residue based gasification systems (50 kW, 30 kW and 20 kW) are recommended for installation at the different unelectrified villages in the block depending upon the biomass availability

Suggested locations

Gasifier system	Location (*one system in each location*)
50 kW	Chandinagar II, IV, Jagdispur III, Kalinagar, Dudpur I
30 kW	Tukargram, Telitikar I, Karaikandi II Madarpur, Dudpur II, Gonirgram III, Gonirgram I
20 kW	Leverputa I, Chandinagar VI, Gobindapur III, Tarinipur II, Sripur I

Investment

Gasifier system	Capital cost (Rs)	O&M / month (Rs)
50 kW	811 250 00	36 738 00
30 kW	521 250 00	24 418.00
20 kW	347 500 00	18 320 00

Note The above costs do not include transmission and distribution costs

Chapter 1

Introduction and methodology

1.1 Introduction

Organic matter derived directly or indirectly from forestry and agricultural or livestock activities, namely wood, crop residues and animal wastes, constitutes the main source of biomass in India. Given the overwhelming dependence of India's rural population on traditional biomass resources for meeting its energy demand, the effective utilization of such resources requires focused planning efforts More so, because of the limited options in terms of fuel sources available in rural areas Though fuelwood continues to be the main domestic fuel in rural households Fuelwood, agricultural residues and animal dung contribute between 90-95% of the total fuel consumed in domestic sector, and fuelwood alone accounts for 65% (NCAER 1985)

It is estimated that approximately 405 million tonnes of biomass is generated every year in the country (MNES 1999) This includes rice husk, saw dust, sugarcane baggasse, coir-pith, coffee wastes and groundnut shells India has a potential of generating 19 500 MW of power by processing biomass through cogeneration, combustion and gasification routes (MNES 1999)

1.2 Objective of the study

The proposed study is being conducted under MNES's taluka level biomass assessment and power generation initiative The overall objective is to provide an assessment of the availability of biomass resources for gasifier based power generation in Katigorah block of Cachar district, Assam The key parameters studied are as follows

1 Assessment of availability, production and utilization of biomass in Katigorah block of Cachar district in Assam through household/village/block level primary survey.
2 Estimation of surplus biomass availability in the block, which could form the basis for planning for power generation
3 Assessment of quantum of electricity to be generated from biomass gasification in the selected block and capacity of power plants to be installed

1.3 Methodology

The study is primarily designed to estimate the availability of likely surplus biomass for power generation in Katigorah block of Cachar district of Assam and the power requirements of the block The focus is on woody biomass and crop residues Secondary data supplemented by primary survey of selected villages are the basis of the

estimations made For the present study, secondary data have been reconciled with primary data collected for corroborating the total information requirements

1.3.1 Secondary data collection

Detailed information was sought from the secondary sources Data related to demographic, social, economic and ecological parameters were collected to understand the land use pattern, resource management systems, productivity of biomass, etc In addition, information was obtained for assessing the technical feasibility of biomass based power generation without putting unsustainable pressures on the biomass resource Apart from the available literature, most of the data collected was based on personal interactions with relevant agencies (Forest Department, ASEB, Agriculture Department, Industries Department, etc) as also with knowledgeable individuals and organizations Table 1 1 provides the details on the type and source of the data collected.

Table 1 1 Type and source of secondary data

Information	Source
District headquarters	
Census records, land use	District Statistical Office
Kerosene supply	District Supply Office
Industrial profile	Directorate of Industries
Power supply and consumption	ASEB
Forest area, sustainable yield of forests	Divisional Forest Office (DFO) Forest Survey of India
Area under crops, land use, irrigation schemes	District Agriculture Office
Block level	
Land use, population, industrial profile, water supply, industries, agriculture markets	Circle Office, Block Development Office, Agriculture Extension Officer, Public Health Engineering Office
Land use, grain productivity, irrigation systems, infrastructure	Rural development Department, Agriculture Extension Officer
Power generation and sale, diesel consumption	ASEB

1 3.2 Selection of villages

All the 67 villages in Katigorah block were considered for the proposed study Out of these, 65 inhabited villages were surveyed for primary data collection

1 3 3 Primary data collection

Primary data were collected from the villages to ascertain the resources available and their utilisation patterns, and the prevalent socio-economic practices An assessment

was made of the electricity consumption and likely demand, crop residue availability, fuelwood use and infrastructural needs In the surveyed villages, structured questionnaires were administered at the household level as well as village level (Annex 1) Group discussions were held to seek the willingness of the populace as suppliers of feedstock for the biomass based power generation facilities The details on the type and source of information collected are presented in table 1 2

Table 1.2 Type and sources of primary information

Information	*Source*
Population, industries, land use, agriculture crop production, development of service sector, etc	Gaon Panchayat Secretary, households, commercial establishments, local shopkeepers
Livestock, biomass collection and consumption, agriculture development, market prices, etc	Households, commercial establishments, village headmen
Power consumption pattern, biomass processed or consumed, electricity bills, kerosene/diesel consumption, power cuts, operational periods, etc	Commercial establishments, restaurants, and households, ASEB

1.4 Data analysis

To assess the biomass supply from the various sources and its consumption by different end-users and the surplus available, computations were based on secondary and primary information Probable sites for power generation are identified and the constraints and pre-requisites associated with the proposed power generation reviewed The following methodology was used to arrive at the estimations

1.4.1 Agriculture residues

This is a factor of agricultural area, crop type, the grain yield and grain to residue ratio

Residue production (t)= crop production (t) × Grain to residue ratio

1 4 2 Woody biomass

The major sources of woody biomass are from the individual homesteads as no forest area is found in the study block Therefore biomass availability from the forest is not taken into account

Total growing stock = Total area under homestead (including plantations) × plant productivity[1] (cu m/ha)

1 Forest Survey of India 1996 Inventory of Forest Resources of India

Annual Sustainable Yield (t) = 1% of total growing stock × density of wood[2]**.** This is also the maximum available sustainable yield on annual basis in tonnes

1 4.3 Assessment of biomass consumption

For the domestic sector, use of fuelwood for different end-uses including cooking and space heating at the household level was assessed to obtain the total annual household wood consumption at the block level Similarly, for crop residues, the quantum used for end-uses of fodder and manure is discounted from the total residue production to estimate the surplus In addition, fuelwood and crop residue harvesting and disposal practices, transportation and storage arrangements, and prevalent market prices of biomass were also studied at the village level The commercial sector in the block comprises mainly of shops and restaurants on the national highway, where biomass mainly firewood is utilised for cooking Based on primary survey, about 17 commercial establishments are in Katigorah block with an average fuelwood consumption of 1200 kg per month/establishment Consumption of woody biomass in the industrial sector is in form of raw materials and these also generate biomass residues

Annual commercial fuelwood consumption = number of establishments × average commercial fuelwood consumption (kg/month) × 12 months

1.4.4 Assessment of power consumption

Power consumption by domestic, commercial and industrial sectors was calculated on basis of primary and secondary surveys Conventional fuel (kerosene) consumption is calculated on the basis of primary survey Kerosene supply is based on the household level consumption pattern found during the primary survey at the block

Total monthly household kerosene consumption = number of households × average household consumption (lit./month)

1 4 5 Power consumption in domestic sector

Total annual consumption (kWh/yr) = Average household power consumption (kWh) × Total households × 365 days

1 4.6 Power consumption in commercial sector

Total annual consumption (kWh/yr) = Power consumption (kWh) per commercial connection × Total commercial establishments × 365 days

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[2] Forest Survey of India 1996 Fuelwood, Timber & Fodder from Forest of India

1.5 Power generation potential

Biomass based power generation is dependent on the type of biomass conversion technology to be adopted and feedstock to be used Biomass conversion technologies are under refinement and the input-output ratios are being standardised for various feedstock, especially for dual fuel mode based gasifier units For the proposed study, the potential for power generation is calculated for gasifiers operating on dual fuel mode technology.

In a gasifier based dual fuel mode of operation, the specific fuel consumption per unit generation is as follows

Wood: 1.0 kg/kWh and Diesel: 100 ml/kWh (Jain 1994)

Crop residue and sawdust: 1.5 kg/kWh (Ankur 1998)

Chapter 2

Profile of taluka

.1 Cachar district

The district of Cachar lies between longitude 92^0 24' E and 93^0 15' E and latitude 24^0 22' N and 25^0 8' N Cachar shares its boundary with Manipur in east, Mizoram in south and Hailakandi district and Bangladesh in the south The total geographical area of the district is 3 786 sq km (Assam State Gazetteer 1999). The Cachar district is divided into two Sub-divisions These are further sub-divided into five administrative Circles Sonai, Silchar, Udharbond, Lakipur and Katigorah encompassing 1 024 villages spread over 163 Gram Panchayats

1.1 *Topography and drainage*

The Cachar district is predominantly an alluvial plain area, it is the headward part of Barak-Surma-Meghna Plain The plain extends to 85 km from the east to the west and about 70 km wide The total area of the plain is about 6 962 km sq. The gradient of the plain from the east to the west is very low (75 m to 51m) and the river Barak flows over it sluggishly through an extremely meandering course The Barak plain is characterised by the presence of scattered isolated low hillocks locally known as *tilas* whose height rarely exceeds 100 m The middle part of the Barak plain through which Barak flows is the lowest part and contains numerous swamps or *beels* and *jhils*

The river Barak, which is the major river in the Cachar district rises from the Barail Range and is joined by numerous tributaries like Jiri, Singla, etc The tributaries of Barak have also built up their own banks, which has resulted in building up of series of bowls The catchments area of Barak up to Badarpur is 25 899 sq km The riverine area in the valley up to the same point measures only about 3 366 sq km This adverse topography and heavy rainfall has made Barak Valley liable to frequent flooding

1 2 *Climate*

The maximum temperatures in Cachar district reach about 32^0 C in summers, but the humidity levels are very high During the month of February and March the air is comparatively less humid, the afternoon humidity being less than 60% The average annual rainfall received by the district is more than 200 cm (Assam State Gazetteer 1999)

2.2 Katigorah block

Katigorah block occupies the southern part of the Cachar district To its east lies the Barkhala and Salchapra blocks, Bangladesh towards west; Kalain block towards north, and Karimganj district in the south, (Fig 2 1) The block falls under the administrative jurisdiction of Katigorah circle, which belongs to the Silchar sub-division

2.2.1 *Demography and socio-cultural profile*

The population of Katigorah is mainly rural, residing in the 67 villages in the block, accounting for 5 83% (70 862 persons) of the district's population (Statistical Handbook 1991) The high density (503 persons/sq km) of population in the block is attributed to the large-scale influx of immigrants from Bangladesh during the year 1941 – 1951, whereas the percentage of increase in the district was by 24 66% The total number of households in Katigorah is 12 144 (Rural Primary Census Abstract 1991) The local inhabitants in the block belong to mainly Bengali speaking Hindu and Muslim communities

2.2.2 *Infrastructure facilities*

The infrastructure facilities in the block are not well developed despite the existence of relatively flat terrain However all the villages in Katigorah are connected to the district headquarters by road, which are partly metalled The nearest railway station is at Badarpur 6 km in Karimganj district, Assam An airport (Kumbirgram) adjoining the district HQ is located at a distance 41 km from the Katigorah block

2.2.3 *Other amenities*

Compared to other blocks in the district, Katigorah enjoys a relatively better position in terms of civic amenities (Table 2 1) Of the total 67 villages in the block, 34 are electrified (ASEB 2000) Most of the villages have been provided with rural water supply schemes facilitated by the local Public Health and Engineering Department In addition to tapping of streams, river and canals for drinking water, open wells and tube-wells are common sources of water Fifty percent of the surveyed villages have ponds facilities and thirty-six percent have open wells facilities, respectively While community taps water facilities are installed close to people's homes, but due to irregular supply of drinking water households have to walk to the nearest well or pond or from the nearest water body

Educational facilities available in the block range from primary to higher secondary schools The local population has access to primary health centres and dispensaries There is a post office (without telegraphic facilities), a Health Centre and a Bank at the block



Figure 2.1 Location of Katigorah block (notional map)

Table 2.1 Distribution of infrastructure facilities in Katigorah

Facility	Katigorah Block
Primary, middle school	102
Secondary, Higher secondary	11
Health centres	1
Post office	1
Co-operative society	-
Bank	1

Source Primary survey 2000-2001

2 2.4 *Land use*

The utilisation of land in the study block is mainly for agriculture and horticulture purposes, and homesteads (Table 2 2) Owing to the availability of relatively flat terrain, land is intensively cultivated for paddy

Table 2 2 Land use pattern in various gram panchayats (GP) of Katigorah block

Land use in G P *(Area in hectares)*	*Gonirgram*	*Dudpur*	*Tannipur*	*Gobindapur*	*Katirail*	*Katigorah*	*Harinagar*	*Leverputa*
Net Cropped area	456 5	570	750	890	1425	798	2074	701
Gross cropped area	528 5	719	880	1032	1625	1046	2480	820
Cropping intensity	116%	126%	117%	116%	114%	131%	119%	117%
Cultivable Waste	3 25	12	25	-	-	-	248	3
Uncultivable Land	-	10	45	28	35	73	89	4
Flood prone area	124	89	272	472	325	594	1224	600
Drought prone area	302	5	-	-	46	-	245	70
Grazing land	-	-	-	-	-	-	19	5
No big Farmers	86	-	38	38	35	47	283	240
No of small farmers	356	170	164	164	225	214	670	570
No of marginal farmers	465	565	718	718	1200	895	737	305
Landless farmers	160	150	186	186	125	682	600	393
Total farm families	1067	885	1106	1106	1585	1838	2290	1508
Av Land holding(ha)	0 40	0 64	0 67	0 80	0 89	0 43	0 90	0 46

Source AEO Katigorah Circle 2000

Note There are 10 Gaon Panchayats (GP) in the block, but information of Siddheswar and Rajatilla GP has been included with Katirail and Harinagar GP respectively

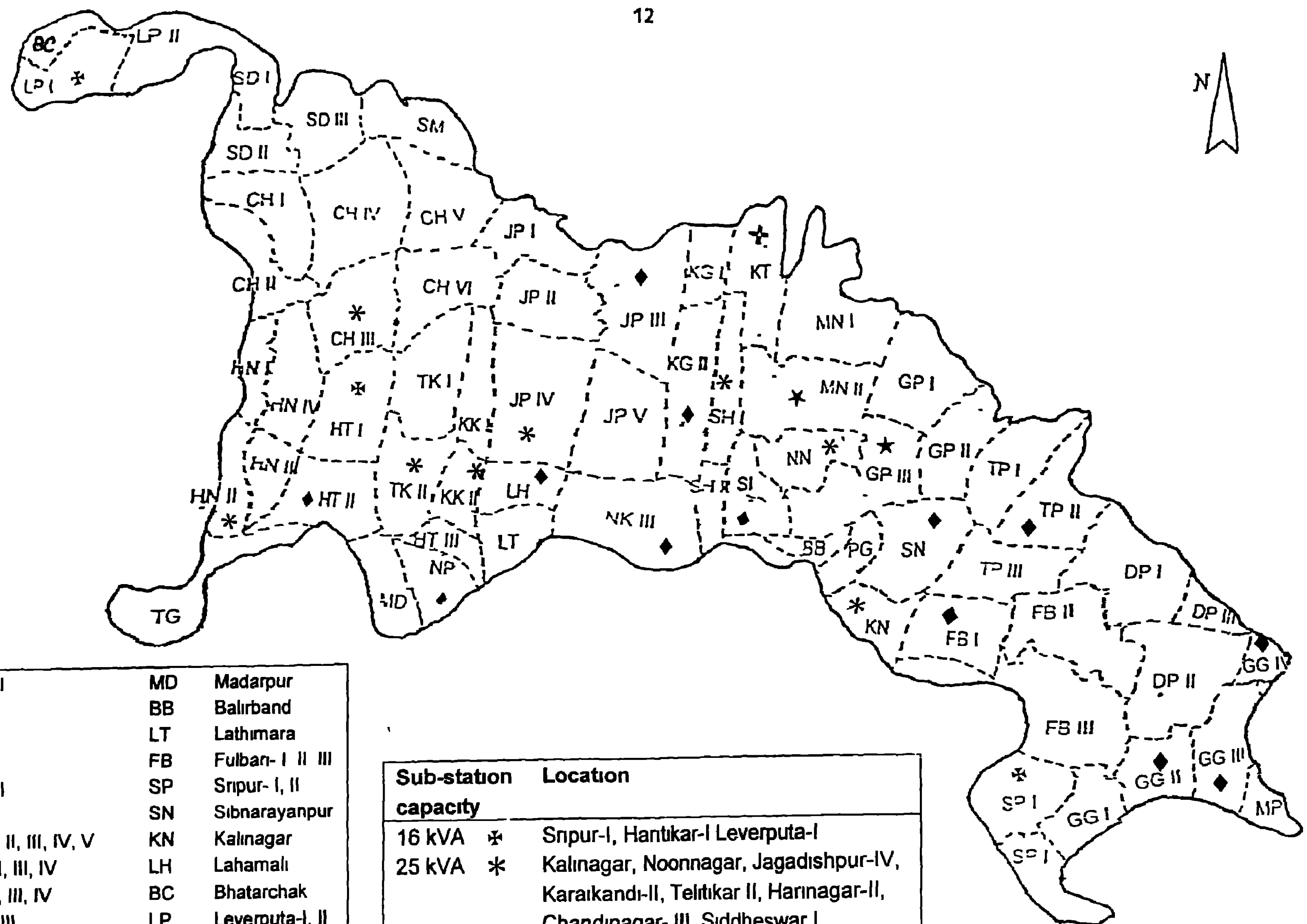
2 2 5 *Scenario of EB substations*

Twenty-seven substations of various capacities (16,25,63, 100, 250 kVA) have been set up for distributing power in the block (Fig 2 2) The ASEB, Silchar Electrical division is responsible for the operation and maintenance of these substations (Table2 3)

Table· 2 3 Distribution of EB substations in the block

Capacity	16 kVA	25 kVA	63 kVA	100 kVA	250 kVA
	Sripur-I,II	Kalinagar	Gonirgram-III	Gobindapur-I,II,III	Katirail
	Haritikar-I	Noonnagar	Gonirgram-IV	Mohanpur-I,II	
	Leverputa-I,II	Siddheswar-I,II	Nijfulbari-I,II,III		
Name of		Jagadishpur-IV	Gonirgram-I,II		
villages		Karaikandi-I,II	Tarinipur-I,II,III		
covered		Telitikar-I,II	Sibnarayanpur		
under each		Harinagar-I,II,III,IV	Siddipur		
sub station		Chandinagar-	Katigora-I, II, III		
		II,III,V,VI	Jagadishpur –I,II,III		
			Lahamali, Lathimara		
			Nazatpur, Haritikar		
Total	**3**	**8**	**13**	**2**	**1**

Source ASEB, Silchar Electrical Division, 2001



NK	Nijkatigorah-III	MD	Madarpur
KG	Katigorah-I, II	BB	Balirband
KT	Katirail	LT	Lathimara
NN	Noonnagar	FB	Fulbari- I II III
MN	Mohanpur- I, II	SP	Sripur- I, II
SI	Siddipur	SN	Sibnarayanpur
JP	Jagadishpur I, II, III, IV, V	KN	Kalinagar
GG	Gonirgram I, II, III, IV	LH	Lahamali
HN	Harinagar-I, II, III, IV	BC	Bhatarchak
HT	Haritikar- I, II, III	LP	Leverputa-I, II
CH	Chandinagar I,II, III, IV, V, VI	SD	Saidpur-I, II, III
KK	Karaikandi- I, II	TG	Tukargram
SH	Sidheshwar-I, II	SM	Salimabad
TK	Telitikar- I, II	DP	Dudpur-I, II, III
GP	Gobindapur-I, II, III	MP	Mahadevpur
TP	Tarinipur- I, II, III	PG	Panchgram
NP	Nazatpur		

Sub-station capacity		Location
16 kVA	✠	Sripur-I, Haritikar-I Leverputa-I
25 kVA	✻	Kalinagar, Noonnagar, Jagadishpur-IV, Karaikandi-II, Telitikar II, Harinagar-II, Chandinagar- III, Siddheswar I,
63 kVA	◆	Gonirgram- II, III, IV, Nijfulbari-III, Tarinipur-II, Sibnarayanpur, Katigora-II, III, Jagadishpur III, Siddipur, Lahamali, Nazatpur, Haritikar II
100 kVA	✶	Gobindapur-III, Mohanpur-II
250 kVA	✣	Katirail

Chapter 3

Baseline data

3.1 Per capita energy consumption

Table 3.1 Per capita domestic annual energy consumption

Type of fuel	Total population	Total annual consumption	Per capita energy consumption
Fire wood	70 862	44 325 6 (t/y)	0 62(t/y)
Kerosene	70 862	1 329 760 (kl /y)	0 01 (kl /y)
LPG	70 862	45 156 (kg/y)	0 63 (kg/y)
Electricity	70 862	1 213 608 (kWh/y)	17 12 (kWh/y)

Source Primary survey 2000

3.2 Domestic electric energy consumption

Table 3.2 Domestic electric energy consumption

Sl No	Village	No of households	No of HH electrified	Total household elect consum kWh/month	Total annual household consumption KWh/year
1	Nijkatigora-III	688	400	10100	121200
2	Katirail	198	160	5980	71760
3	Noonnagar	287	150	4250	51000
4	Tukargram	150	0	-	-
5	Mohanpur-I	101	50	1787	21444
6	Mohanpur-II	248	95	3949	47388
7	Siddhipur	205	155	4938	59256
8	Jagadishpur-V	306	190	5645	67740
9	Lathimara	367	100	3600	43200
10	Lahamali	77	16	496	5952
11	Jagadishpur-III	61	0	-	-
12	Harinagar-I	173	45	1350	16200
13	Harinagar-II	152	70	2530	30360
14	Harinagar-III	76	30	970	11640
15	Harinagar-IV	93	40	1225	14700
16	Haritikar-I	98	6	240	2880
17	Chandinagar-II	280	0	-	-
18	Chandinagar-III	178	0	-	-
19	Chandinagar-V	16	0	-	-
20	Chandinagar-VI	136	0	-	-
21	Karaikandi-I	80	0	-	-

22	Karaıkandı-II	165	0	-	-
23	Madarpur	187	0	-	-
24	Telıtıkar-I	61	0	-	-
25	Telıtıkar-II	201	0	-	-
26	Harıtıkar-II	270	62	2258	27096
27	Gonırgram-II	153	25	900	10800
28	Gonırgram-I	145	0	-	-
29	Nazatpur	244	30	1018	12216
30	Jagadıshpur-IV	311	110	5080	60960
31	Jagadıshpur-I	13	0	-	-
32	Jagadıshpur-II	22	0	-	-
33	Fulbarı-III	357	80	2720	32640
34	Fulbarı-II	41	0	-	-
35	Srıpur-I	191	0	-	-
36	Srıpur-II	216	110	4190	50280
37	Tarınıpur-I	145	100	4618	55416
38	Tarınıpur-II	25	0	-	-
39	Tarınıpur-III	270	180	5400	64800
40	Nıjfulbarı-I	406	200	7200	86400
41	Kalınagar	180	0	-	-
42	Bhatarchak	44	0	-	-
43	Leverputa-I	140	0	-	-
44	Leverputa-II	262	0	-	-
45	Saıdpur-I	123	15	870	10440
46	Saıdpur-II	135	20	750	9000
47	Saıdpur-III	91	0	-	-
48	Chandınagar-I	139	20	664	7968
49	Chandınagar-IV	194	0	-	-
50	Salımabad	179	0	-	-
51	Dudpur-I	267	0	-	-
52	Dudpur-II	59	0	-	-
53	Dudpur-III	261	0	-	-
54	Gonırgram-III	259	0	-	-
55	Gonırgram-IV	304	20	800	9600
56	Mahadevpur	66	0	-	-
57	Sıbnarayanpur	282	140	5700	68400
58	Gobındapur-I	52	0	-	-
59	Gobındapur-II	173	50	1830	21960
60	Gobındapur-III	432	0	-	-
61	Panchgram	42	0	-	-
62	Sıddheshwar-II	227	125	4030	48360
63	Sıddheshwar-I	53	0	-	-
64	Katıgora-II	699	165	6046	72552
65	*Balırband(un)	39	-	-	-
66	*Katıgorah I (un)	49	-	-	-
	Total	**12 144**	**2 959**	**101 134**	**1 213 608**

Source Prımary survey 2000

*Balırband and *Katıgorah are the two unınhıbıted vıllages ın the block But accordıng to 1991 census these vıllages supported 39 and 49 households, respectıvely

3.3 Village-wise energy consumption

Table. 3.3 Village wise energy consumption

Sl No	Name of village	No of HH	Total annual energy consumption		
			Fuelwood (t/y)	Kerosene (kl/y)	LPG (kg/y)
1	Nijkatigora-III	688	1556 7	28	2044 8
2	Katirail	198	556 6	23	511 2
3	Noonnagar	287	1257	36	852
4	Tukargram	150	481 8	17	1022 4
5	Mohanpur-I	101	516	22	340 8
6	Mohanpur II	248	842 4	30	1192 8
7	Siddhipur	205	840 9	24	1363
8	Jagadishpur-V	306	1076	30	2215
9	Lathimara	367	905	21 7	2896 8
10	Lahamali	77	193 4	4 4	511 2
11	Jagadishpur-III	61	222 6	7 1	1192 8
12	Harinagar-I	173	465 7	16 7	1192 8
13	Harinagar-II	152	499 3	19 4	1704
14	Harinagar-III	76	305	8 4	511 2
15	Harinagar-IV	93	435 4	11 4	852
16	Haritikar-I	98	482 5	12 6	-
17	Chandinagar-II	280	747	26 4	-
18	Chandinagar-III	178	697	23	-
19	Chandinagar-V	16	98 5	1 4	-
20	Chandinagar-VI	136	527 4	16 5	-
21	Karaikandi-I	80	182 5	10 5	-
22	Karaikandi-II	165	870 8	21	-
23	Madarpur	187	757 7	25 6	2044 8
24	Telitikar-I	61	346	6 7	-
25	Telitikar-II	201	872 3	29 2	-
26	Haritikar-II	270	963 6	30	1363
27	Gonirgram-II	153	657 3	17	511 2
28	Gonirgram-I	145	467 2	17 3	852
29	Nazatpur	244	820 8	38 2	-
30	Jagadishpur-IV	311	1092	37 5	-
31	Jagadishpur-I	13	44 16	1 5	-
32	Jagadishpur-II	22	116 8	2 4	-
33	Fulbari-III	357	1577 8	47 3	3067
34	Fulbari-II	41	104	5	-
35	Sripur-I	191	813 2	23 6	2044 8
36	Sripur-II	216	1130 7	25 4	-
37	Tarinipur-I	145	880 3	17 4	1704
38	Tarinipur-II	25	138 7	2 8	-
39	Tarinipur-III	270	696 4	32 6	-
40	Nijfulbari-I	406	1518 4	46	2556
41	Kalinagar	180	655	20	681 6
42	Bhatarchak	44	254	4 6	-

43	Leverputa-I	140	481 8	15	-
44	Leverputa-II	262	1053	31	-
45	Saidpur-I	123	691 3	14	-
46	Saidpur-II	135	677 4	15 4	1533 6
47	Saidpur-III	91	302 9	11 52	-
48	Chandinagar-I	139	898 2	15	-
49	Chandinagar-IV	194	858	21 4	-
50	Salimabad	179	703 3	21 3	-
51	Dudpur-I	267	787 67	38 3	1533 6
52	Dudpur-II	59	206 9	6	-
53	Dudpur-III	261	984 4	31 5	2215 2
54	Gonirgram-III	259	970 9	30 5	-
55	Gonirgram-IV	304	1163 9	37 6	1704
56	Mahadevpur	66	281	6 7	-
57	Sibnarayanpur	282	1199 7	36	3408
58	Gobindapur-I	52	193 4	5 6	1192 8
59	Gobindapur-II	173	660 2	15 4	-
60	Gobindapur-III	432	1265	30 5	-
61	Panchgram	42	228 8	6	-
62	Siddheshwar-II	227	935	26 4	-
63	Siddheshwar-I	53	237 2	6	340 8
64	Katigora-II	699	1879 7	68 2	-
65	*Balirband(un)	39	-	-	-
66	*Katigorah I (un)	49	-	-	-
	Total	**12 144**	**44 325.6**	**1 329.76**	**45 155.2**

Source Primary survey 2000

3.4 Industry level energy consumption

Table 3.4 Industry level energy consumption

Type	Location	Capacity	Energy consumption per annum		
			Diesel(lit)	Electricity(kWh)	Coal(tonne)
Rice Mill	Karaikandi-II	5 HP	1800	-	-
Rice Mill	Chandinagar-I	5 HP	1620	-	
Rice Mill	Tarinipur-I	5 HP	1500	-	-
Rice Mill	Gobindapur-II	10 HP	-	1680	-
Rice Mill	Haritikar-I	8 HP	720	-	-
Rice Mill	Dudpur-I	5 HP	1440	-	-
Rice Mill	Chandinagar-II	5 HP	1800	-	-
Rice Mill	Tukargram	5 HP	1260	-	-
Rice Mill	Dudpur-II	8 HP	1800	-	-
Rice Mill	Haritikar-II	5 HP	1600	-	-
Rice Mill	Chandinagar-IV	5 HP	1800	-	-
Rice Mill	Siddipur	5 HP	1400	-	-
Saw Mill	Siddipur	20 HP	-	7800	-
Brick Kiln	Mohanpur-I	-	-	-	540
	Total		**16 740**	**9480**	**540**

Source Primary survey 2000

3.5 Energy consumption of commercial activities/public utilities, agricultural activities and other misc. activities

Table 3 5 Energy consumption of commercial activities

Type of establishment	No units	Annual energy consumption			
		Fuel wood(t)	Coal (t)	Kerosene (lit)	Electricity (kWh)
Restaurant	**17**	**244**	**-**	**-**	**6 120**

Source Primary survey 2000

*Fuelwood consumption is 40 kg/d (avg) and electricity consumption is 30 unit/month (avg) by each unit respectively

Chapter 4

Biomass generation as per land area classification

.1 Biomass from forests

The Cachar district covers a geographical area of 3 78 600 ha, of which forests cover accounts for 73 95 57 ha (19 35%) Katigorah block comprises 10 Gaon Panchayats (G P) with an area of 14 357 9 ha A part of Kalain forest Range falls under the Katigorah block Currently there are no records of Reserve Forests in the block as informed by the Forest Department (District Forest Officer, Karimganj 2000) As there is no recorded area under forests in Katigorah, hence biomass supply from such lands is not taken into account

.2 Biomass from homesteads

Homesteads comprise the primary source of biomass for use in the domestic sector in the block The area under homestead plantation is 4 857 60 ha, maintained by 12 144 households, based on primary survey The composition of vegetation in the homestead includes trees, bamboo, and shrubs Table 4 1 presents land area for biomass availability under homesteads and the productivity of biomass Thus, total woody biomass production from homesteads 40 803 84 t/year

Table 4 1 Biomass generation from homestead

Land type	Area* (ha)	Biomass type	Productivity[1] (tonne/ha)	Total growing stock (tonne/year)	Sustainable yield (1% of growing stock) tonne/year
Homestead	4857 6	Trees (*jackfruit, mango, jamun, fansh, kadam, simul, bamboo etc*)	8 4	40 803 84	408 03

Source Primary survey 2000

*Out of the total area under homesteads, 80% is tree biomass and remaining 20% is bamboo plantation, as informed by the villagers during primary survey

[1] Hazarika N, Agarwal S et al 1997

4.3 Biomass from grazing lands, cultivable wastes, and uncultivable lands

The biomass available in grazing land, cultivable wastes and uncultivable lands is usually grass and scrub, and these areas are not restricted to a specific area. The total biomass production from such lands is about 1423 85 t/y (Table 4 2)

Table 4 2 Biomass generation from miscellaneous areas

Land type	Area (ha)	Biomass type	Productivity[2] (tonne/ha)	Total growing stock (t/year)	Sustainable yield (tonne/year)
Grazing land	24	Grass	1 5	36 00	0 36
Cultivable waste	291 25	Grass, shrubs	3 4	990 25	9 90
Uncultivable land	284	Shrubs	1 4	397 60	3 97

Source AEO Katigorah, 2000

4.4 Biomass from agriculture land

Agriculture residues

The major agricultural crop grown in the block is paddy covering an area of 5645 4 ha, constituting 87 72% of the total cultivable area Mixed cropping is practised in the large tracts in the block and crops such as mustard, black gram, peas, jute, rapeseed and potatoes are grown. Based on the area under cultivation under each crop in the study area, only field crops such as paddy, black gram and rapeseed and mustard are taken into account, as the production of other crops is not so substantial Tables 4 3 and 4 4 present the production of paddy and other minor crops and their corresponding residue availability, respectively Thus the total annual agricultural residue generated is 22 436 86 t/year

Table 4 3 Residue generation of major crops in Katigorah block (1999)

Crop	Season	Production (t/y)	Total production (t/y)	Type of residue	Crop/Residue ratio[3]	Residue production (t/y)
Paddy	Summer	1542 87		Straw	1 76	19 233 63
	Autumn	1879 17	10 928 20	Husk and hulls	0 267	2 917 82
	Winter	7506 16				

Source Primary survey 2000

Table 4.4 Residue generation of minor crops in Katigorah block (1999)

Crop	Production(t/y)	Crop/Residue ratio[3]	Type of residue	Residue production (t/y)
Rapeseed & mustard	63 9	2 5	Stalk	159 75
Black Gram	50 26	2 5	Straw	125 66

Source A E O (VLEW) Katigorah block 2000

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[2] Forest Survey of India 1996

[3] Baruah DC, Jain AK 1998

Chapter 5
Biomass scenario in industries

5.1 Biomass generating industries

Table 5 1 Type and distribution of biomass generating industries in Katigorah

Industry	*Units*	*Locations*	*Type and amount of residue generated*
Rice Mill	12	Haritikar-I, Gobindapur-II, Tarinipur-I, Dudpur-I Dudpur- II, Chandinagar-VI, Tukargram, Karaikandi-II, Haritakar-II, Chandinarag-I , Chandinarag-II, Siddipur	Husk 2 917 82 t/y

Source Primary survey 2000

5.2 Biomass generation and consumption industries

Table 5 2 Biomass generating and consuming industries in Cachar and Katigorah

Industry type	*Units*	*Locations*	*Type and amount of residue*
Bamboo splitting *	5	Katigorah, Siddipur, Sidheshwar	Bamboo scrap 5 05 t/year
Saw Mill	1	Siddipur	Saw dust NA

Source Primary survey 2000

* Bamboo splitting industry is a small-scale cottage industry, wherein crushing and splitting of bamboo poles is undertaken by unskilled manpower, amount of residue generated is based on primary survey

5.3 Biomass consuming industries

Table 5.3 Types and distribution of biomass consuming industries in Cachar and Katigorah

Industry	*Unit*	*Location*	*Type and amount of biomass consumed*
Brick kiln	1	Mohanpur I	Coal 540 t/y
Restaurant	17	Katigorah	Fuelwood 244 t/y

Source Primary survey 2000

5.4 Biomass from allied industries

There exists no such allied industrial unit in the block, which generate or consume biomass as an energy source

Chapter 6

Biomass consumption and surplus availability

6.1 Land

6.1.1 Surplus biomass from different land categories

Table 6 1 Consumption and surplus biomass from homestead and miscellaneous lands

Type of biomass	Land type	Generation t/y	Utilisation t/y		Surplus/ (deficit) t/y
			Cooking	Fodder	
Woody	Homestead	40 803 84	44 325 6	0	(3 521 76)
Grass, shrubs	Cultivable waste	990 25	0	495 12	495 13
Shrubs	Uncultivable land	397 60	0	318 08	79 52
Grass	Grazing land	36 00	0	28 2	7 8

Source Table 4 2, Primary survey 2000

6.1.2 Agriculture

Table 6 2 Crop residues from cultivable land

Residue type	Generation t/y	Consumption t/y				Surplus t/y
		Fodder	Mulching	Cooking	Sold to traders	
Paddy husk	2 917 82	29 17	58 36	58 36	583 56	2188 37
Paddy straw	19 233 63	19 233 63	-	-		None
Rapeseed & Mustard stalk	159 75	-	-	-	-	159 75
Black gram straw	125 66	-	-	-	-	125 66

Source Table 4 2, Primary survey 2000

6.2 Industries

There are 18 biomass-generating units, out of which 12 units are spice & paddy mills, 5 bamboo splitting units and 1 sawmill There are 18 biomass consuming units, of which 17 are restaurants and 1 brick kiln

6 2.1 Surplus agro residues from biomass generating industries

Table 6 3 Surplus agro residues from biomass generating industries in Katigorah

Industry type	*Units*	*Generation t/y*	*Utilization t/y*	*Surplus t/y*
Bamboo splitting	5	5 05	0	5 05
Spice & Paddy mill	12	12	0	12
Saw Mill	1	0 (out of operation)	0	0
Total	**18**	**17 05**	**None**	**17 05**

Source Primary survey 2000

6.2.2 *Surplus agro residues from biomass generating and consuming industries*

Table 6.4 Biomass generating and consuming industries in Katigorah

Industry type	*Units*	*Generation t/y*	*Utilization t/y)*	*Surplus t/y*
Bamboo splitting	5	5 05 t/y	0	5 05 t/y
Spice & Paddy Mill	12	12 t/yr	0	12 t/y
Saw Mill	1	0 (out of operation)	0	0
Total	**18**	**17.05**	**None**	**17 05**

Source Primary survey 2000

6.3 Summary table

Table 6.5 Status on availability of biomass in the block

Type of biomass	*Generation t/y*	*Consumption t/y*				*Surplus/(deficit) t/y*
		Fodder	Cooking	Mulching	Sold to traders	
Woody	40 803 84	-	44 325 6	-	-	(3 521 76)
Grass, shrubs	990 25	495 12	-	-	-	495 13
Shrubs	397 60	318 08	-	-	-	79 52
Grass	36 00	28 2		-	-	7 8
Agri residue	22 436 86	19262 8	58 36	58 36	583 56	2 473 78
Industry residue	17 05	-	-	-	-	17 05

Note Biomass generated from industry and agriculture land is mainly paddy residue. Thus paddy residue has been accounted for both under agriculture residue and industry residue

Chapter 7

Surplus biomass availability

7.1 Agriculture land

Out of the Katigorah's total geographical area of 14 358 ha, cultivable area accounts for 6 434 96 ha (44 8%) Field crops such as *Boro(Summer)*, *Ahu(Autumn)* and *Sali(winter)* varieties, rapeseed and mustard, blackgram, arhar, pea and jute grown in different seasons cover an area of 5 948 29 ha Out of all the field crops *Sali* paddy comprises primary crop covering an area of 3 607 ha followed by *Ahu* (1 108 ha) and *Boro* (930 ha) Total annual production of *Sali* paddy is 7 506 16t, *Ahu* 1879 17 t and *Boro* 1542 87 t (Table 7 1) Out of the total residue production, 100 % of the total straw production is utilised as fodder and an additional 5% of the available husk production is utilised for mulching, fodder and home fire and 20% of total grain production is sold to the traders Therefore the available surplus residue is 2188 34 t/y The surplus residue which is mainly husk is available at the rice mills at a cost of Rs 1 00/kg

7 1 Residue generated from major crops (1998-99)

Paddy	*Seasonal availability*	*Area (ha)*	*Yield[1] t/ha*	*Production t/y*	*Residue t/y*	*Surplus t/y*
Winter	Nov-Dec	3607 0	2 081	7 506 16	Husk 2004 14	Husk 1503 10
					Straw 13210 84	Straw None
Autumn	June-July	1108 0	1 696	1879 17	Husk 501 73	Husk 376 29
					Straw 3307 33	Straw None
Summer	April –May	930 0	1 659	1542 87	Husk 411 94	Husk 308 95
					Straw 2715 45	Straw None
Total		**5645 0**		**10928 20**	**Husk 2917 82**	**Husk 2 188 37**
					Straw 19233 63	**Straw None**

Source A E O (VLEW) Katigorah Block 2000

A number of field crops having lesser area under cultivation than paddy can be considered as minor crops These are namely rapeseed, mustard, black gram, pea, arhar, and lentil, covering an area of 275 ha in different seasons Out of these crops rapeseed and mustard, and black gram are found to be favoured for cultivation by the farmers and occupy an area of 190 66 ha Considering these two crops as the dominant minor crops,

[1] District Agriculture Office 2000

the total annual residue generated is 285 41 tonnes (Table 7 2) Residues from minor crops do not have any commercial value.

7.2 Residue generated from minor crops (1999-2000)

Minor crops	Seasonal availability	Area ha	Yield[2] t/ha	Production t/y	Residue t/y	Surplus t/y
Rapeseed & mustard	Jan-Feb	104 0	0 612	63 9	159 75	159 75
Black gram	Nov-Dec	86 66	0 58	50 26	125 66	125 66
Total		**190 66**		**114.26**	**285.41**	**285 41**

Source VLEW, Katigorah

7.2 Industries

The general presence of industries in the block is very poor Rice mills and bamboo splitting units are some of the biomass generating units that are found in the block other than a single sawmill,which is facing closure However, the quality of biomass wastes generated by the bamboo splitting industries/units is extremely poor Therefore residue generation from these units cannot be considered as surplus for power generation Table 7 3 provides a scenario of biomass generating industries

Table 7 3 Biomass generating industrial units in Katigorah

Industry type	*No units*	*Residue generation (t/yr)*
Bamboo splitting	5	6
Rice mill	12	12*
Saw mill	1	Nil
Total		**6**

Source Primary survey, 2000-2001

* Biomass generated from the rice mills is taken into account as a part of the total residue surplus available in the block

Table 7.4 Surplus biomass from generating and consuming industries

Industry type	*Units*	*Generation t/y*	*Utilisation t/y*	*Surplus t/y*
Bamboo splitting	5	6	0	6
Rice Mill	12	12	0	12
Saw Mill	1	0 (out of operation)	0	0

Source Primary survey, 2000-2001

The industries/units that generate and consume biomass simultaneously (Table 7 4) are the same units considered in table 7 3 Therefore the surplus biomass available under this category is not considered

[2] District Agriculture Office 2000

Chapter 8

Biomass collecting mechanism and management

8.1 Seasonal availability and cost

Agricultural biomass generated in the district can be grouped under two categories, namely major and minor crops Major crops comprise paddy *Ahu (*Autumn*), Sali(*winter*) and Boro*(summer) and minor crops include oilseed and pulses Bulk agricultural residues (straw and husk) are available from paddy during the harvesting season for each crop (March-April for *Boro*, June-July for *Ahu* and November-December for *Sali*) There is an interval of three months in the harvesting of *Ahu* and *Sali* Minor crops selected for contribution to biomass production is based on the area under cultivation and production In the present study rapeseed and mustard, and black gram have been considered The sequence of biomass availability would start with rapeseed and mustard (Jan-Feb), followed by the varieties of paddy namely *Boro* (April –May), *Ahu* (June-July) and *Sali* together with black gram (Nov-Dec) In this sequence it has been observed that there is a constraint related to biomass availability during the months of September and October only Paddy is a principal crop and cash inflow in rural livelihood is largely controlled by the sale of the paddy and rice in the local markets other than consumptive use Besides it is well known that after dehusking, paddy cannot be stored in bulk in a rural environment because of high humidity levels Therefore paddy is stored without processing Hence, rice husk availability can be assumed to concentrated in the rice mills throughout the year

Table 8.1 Seasonal availability of biomass and pricing in Katigorah (1999-2000)

Crop	*Harvest season*	*Surplus residue Availability* (t/y)	*Cost*
Winter Paddy	Nov to Dec	1503 10	The surplus biomass which is
Autumn Paddy	June to July	376 29	mainly husk is available at the rice
Summer Paddy	April to May	308 95	mills at a cost of Rs 1/kg
Rapeseed and Mustard	Jan to Feb	159 75	The minor crop residues do not have any commercial value
Black Gram	Nov to Dec	125 66	
Fuelwood	*All year round*	None	Rs 200/ quintal
Grass	*All year round*	None	Zero cost

*Only the husk is considered

8.2 Sourcing mechanism

8 2 1 Agriculture residues

With extensive land under paddy cultivation in the plain areas of Katigorah, crop residues are easily accessible, and wet agriculture tracts are located closer to the main settlements Harvesting of major and minor crops and the collection of crop residues is seasonal activity, handled by the farmers themselves For crop residue to be used as a feedstock for power generation, the collection process will vary for major and minor crops

8 2 1 1 Major crop

Dehusking is a regular activity, and the collection of husk from households/villages will have to be organised and done on a weekly or fortnightly basis and stored at a central point within the village for transportation There are numerous rice mills other than those registered For procuring husk from such mills, arrangements with the mill owners will have to be worked out for supply of the desired quantum of husk generated to the power generation site These mills in respective villages can become the collection centres

8 2.1.2 Minor crops

Rapeseed and mustard and black gram being seasonal crops, the stalks could be collected soon (within a month) after harvesting in the respective villages, and transported to the nearest collection centre or the power generation site

If the option of stand-alone gasifier units at the village-level is exercised, then the households can undertake the collection of residues in respective villages, collectively.

8.3 Biomass costing

8 3 1 Agriculture residues

Currently, crop residues constitute a free source of manure and fodder, and are available at a zero cost, but a certain percentage is utilised for fuel and fodder The consumption of residues is dependent on the needs of the households, and there is no commercial demand for these But very often, the smaller rice mill owners may keep the husk generated in lieu of the payment for dehusking charges Sometimes, households buy husk from the mills at a cost of Rs 1 00 per kg husk

In event of the large demand created by residue based power generation, pricing of residue would be critical issue The use of residue as feedstock implies that diverting this resource (from use as fodder and manure) would call for purchase of fertilisers and fodder alternatives, which may not be readily available Thus the price which the household/seller gets should be able to cover the cost of its substitutes The sale of

residues poses an attractive proposition foi the households because a regular flow of income would be ensured especially when employment opportunities are few

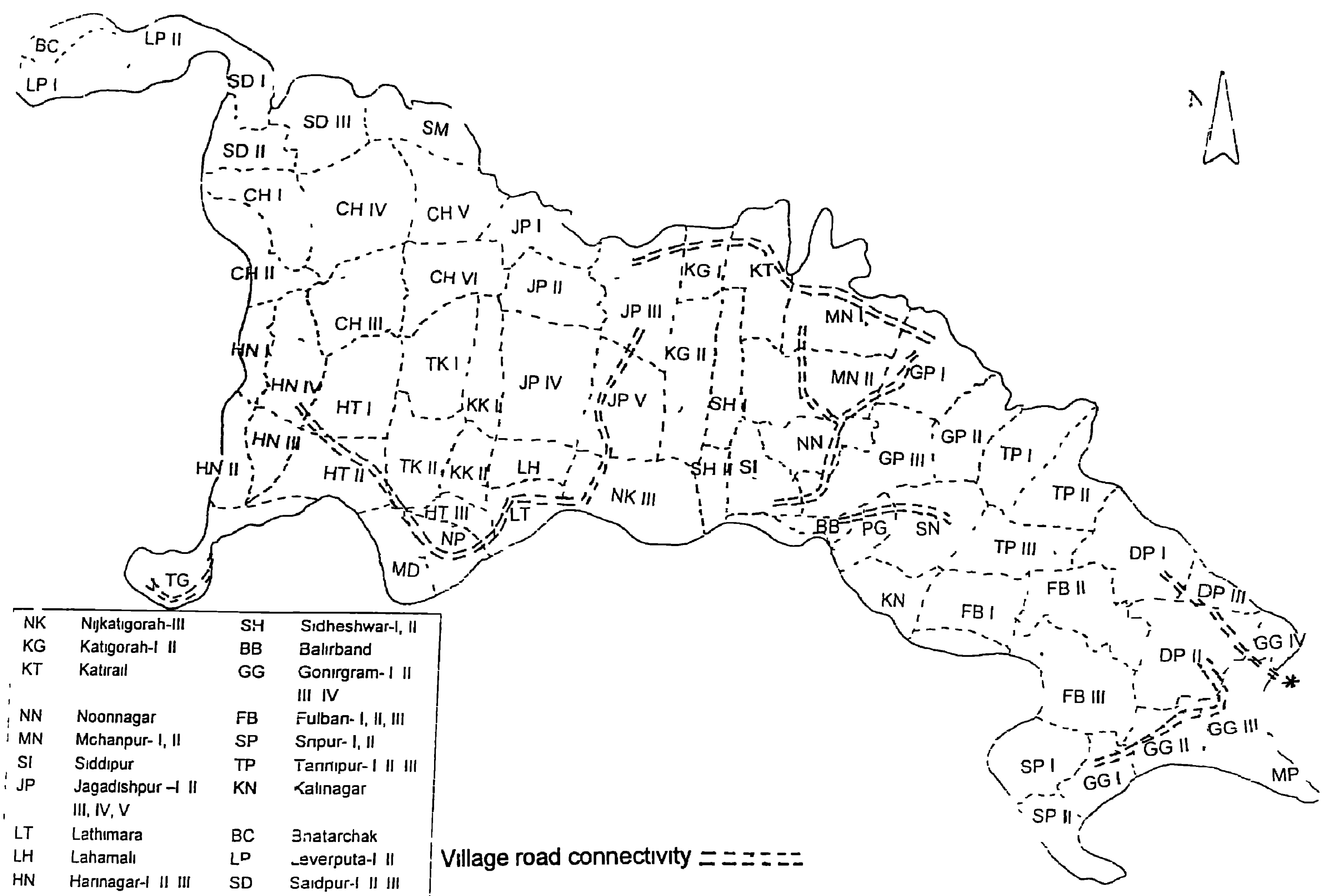
8.3.2 Transportation of biomass

The communication network in Katigorah comprises a netwoik of metalled, fair-weather and motorable roads connecting all the villages (Figure 8 1) to the block headquarters Most villages are located within a distance of about 12 km radius of the block headquarters, and are connected with non-metalled ioads In all the surveyed villages the average distance to the metalled ioad is about 7 km Geneially people transport the paddy from the fields to the houses on foot Based on the demand for processing, paddy is transported to the milling centres on bicycle and handcarts Thereafter the grain and a percentage of the husk are usually transported within and outside the village by bicycles and handcarts The same applies for transportation of minor crops Almost every household in the village possesses a bicycle and for every 10 households a handcart is available Handcarts can be hired at the rates ranging from Rs 20 to Rs 30 for a full load of 200 kg for a distance of 3 to 5 km

Table 8.2 Overview of road connectivity in the block

Connecting road	*Metal*	*Gravel*	*Total*
1 Katigora Harinager Rd	2 60	7 40	10 00
2 Tilain Rajnagar Katigora Rd	8 744	5 30	14 0
3 Haritikar Sadirkhel	Nil	8 62	8 62
4 Salchepra Ferry Ghat to Dudpur Village Rd	Nil	4 66	4 66
5 Gobindapur to Mohanpur via Noonnagar	Nil	2 65	2 65
6 Tarinipur Sealtek Rd (G P V R)	Nil	1 10	1 10
7 Betara Bhubaneswar Rd	Nil	2 61	2 61
8 Tarinipur Sealtek Rd	Nil	1 00	1 00
9 Katigora Gobindapur via Jagadishpur Rd	Nil	2 805	2 805
10 Gobindapur to S N Rd	Nil	1 65	1 65
11 Gonirgram to Dudpur Village	Nil	0 50	0 50
12 Karailigndi to Jabba Rd	Nil	1 371	1 371
13 Mohanpur to Sukritipur Rly station Rd	Nil	0 71	0 71
14 Sibnarayanpur Balirband Rd	Nil	0 210	0 210
15 Siddiqpur Noonnagar Rd	Nil	1 10	1 10
16 Kinorkhal to Subodhnagar	Nil	0 80	0 80
17 Tukargram Border Rd -	Nil	1 00	1 00

Source PWD department, Katigorah



NK	Nijkatigorah-III	SH	Sidheshwar-I, II
KG	Katigorah-I II	BB	Balirband
KT	Katirail	GG	Gonirgram- I II III IV
NN	Noonnagar	FB	Fulbari- I, II, III
MN	Mohanpur- I, II	SP	Sripur- I, II
SI	Siddipur	TP	Tarinipur- I II III
JP	Jagadishpur –I II III, IV, V	KN	Kalinagar
LT	Lathimara	BC	Bhatarchak
LH	Lahamali	LP	Leverputa-I II
HN	Harinagar-I II III IV	SD	Saidpur-I II III
HT	Haritikar- I II III	CH	Chandinagar-I I, III IV V VI
CH	Chandinagar – I II III IV V VI	SM	Salimabad
KK	Karaikandi- I II	DP	Dudpur-I, II III
MD	Madarpur	MP	Mahadevpur
TK	Telitikar- I II	SN	Sonarayanpur
GP	Gobindapur-I II III	PG	Panchgram

Village road connectivity = = = = = =

Figure 8 1 Village road connectivity in Katigorah

Chapter 9

Biomass consuming industries

9.1 Biomass consuming industries:

The industrial base in Katigorah is extremely poor Other than the 12 large spice and rice mills that operate within the block, there is no other large industrial activity A single brick kiln located in Katigorah village is also facing closure The brick kiln was operating only on coal imported from outside the block Therefore, the use of local biomass was ruled out Table 9 1 presents the distribution of industries in the block

Table 9.1 Distribution of industries in Katigorah

Industry	*No of units*	*Location*
Brick kiln	1	Mohanpur I
Spice and rice mills	12	12 different villages [see table 5 1]

Source Primary survey 2000

Even though biomass consuming industries are absent in the block, other establishments that consume an appreciable quantity of biomass are the restaurants located on the national highway About 17 small restaurants, mostly tea stalls, are found in the Katigorah block headquarters Such units consume an average of 35 kg firewood daily, amounting to total use of 217 17t wood annually Burning of firewood in the restaurants is carried out in earthen cookstoves The use of improved cookstoves in such establishments would help in reduction of the firewood consumption by about 20% resulting in considerable firewood saving annually However, field trials on energy savings from improved cookstoves at individual level are yet to be undertaken in the block Thus energy savings cannot be computed based on assumptions Given the low consumption of firewood (35 kg/day) in this sector, fuel saving interventions may not be worthwhile

Chapter 10

Possible power generation potential, location and economics

The current household power consumption in Katigorah is 51 MW/ annum, but if all the households in the block were to be electrified (*assuming the current annual consumption levels of households at 17 kW)*, the block's total demand would be 206 MW annually Thus there is a power deficit of 75% Among the various sectors, domestic sector emerges as the largest consumer (98 73%) followed by industry (0 77%) and commercial sector (0 50%) With the power supply coming from the grid, it is envisaged that with the expansion of the grid network and the high percentage of non-electrified villages, there will be a rise in the domestic demand for power in future At present, ASEB does not have any plans to electrify the 33 un-electrified villages (49 25%), which calls for interventions through renewables Thus the alternate option for supplying power is by generating power through biomass conversion routes, particularly at the village-level through decentralised systems or through centralised power generating units close to the grid

10.1 Power generation potential

Among all the biomass resources assessed, the most promising is agriculture residues The availability of crop residues provides an option for power generation through gasification as no surplus woody biomass is available for power generation This is substantiated by the fact that the annual consumption of firewood (44 325.6 t) exceeds the total generation of 40 803 84 t/y Under the present circumstances, with a deficit of 3 521 76 t wood annually, there exists no potential for utilization of wood for power generation The major agricultural crop residue generated within the block is mainly from paddy, and contributes 22 151 45 tonnes (98 %), out of the total annual biomass production of 22 436 86 tonnes Straw is a major source for fodder in the villages and 100% of the total straw production is being utilised at the village level, therefore the total straw biomass amounting to 19 233 63 tonnes cannot be considered Rice husk contributes 2 917 82 t/year, but owing to commercial sale of paddy, it is assumed that 20 % of the total husk production would not be available An additional 5 % of the total husk production finds its utilization against fodder, mulching and homefire burning, therefore the potential paddy husk available is 2 188.36 t/y Further, minor crop residues such as rapeseed and mustard and black gram do not have significant uses, and surplus residue available from such crops is 285 41 t/y Considering the processing and transportation losses @ 20% of the total surplus available, a net amount of 1979 02 is available in the block, This surplus will be able to

generate to generate 3614 65 kWh daily through dual fuel-based gasifier (Tables 10 1 and 10 2).

Table 10.1 Biomass based power generation potential

Type of biomass	*Surplus biomass available (t/y)*	*Actual biomass available[1] (t/y)*	*Biomass fuel input required for gasifier with dual fuel mode*
Crop residue	2 473 78	1 979 02	1 5 kg/kWh

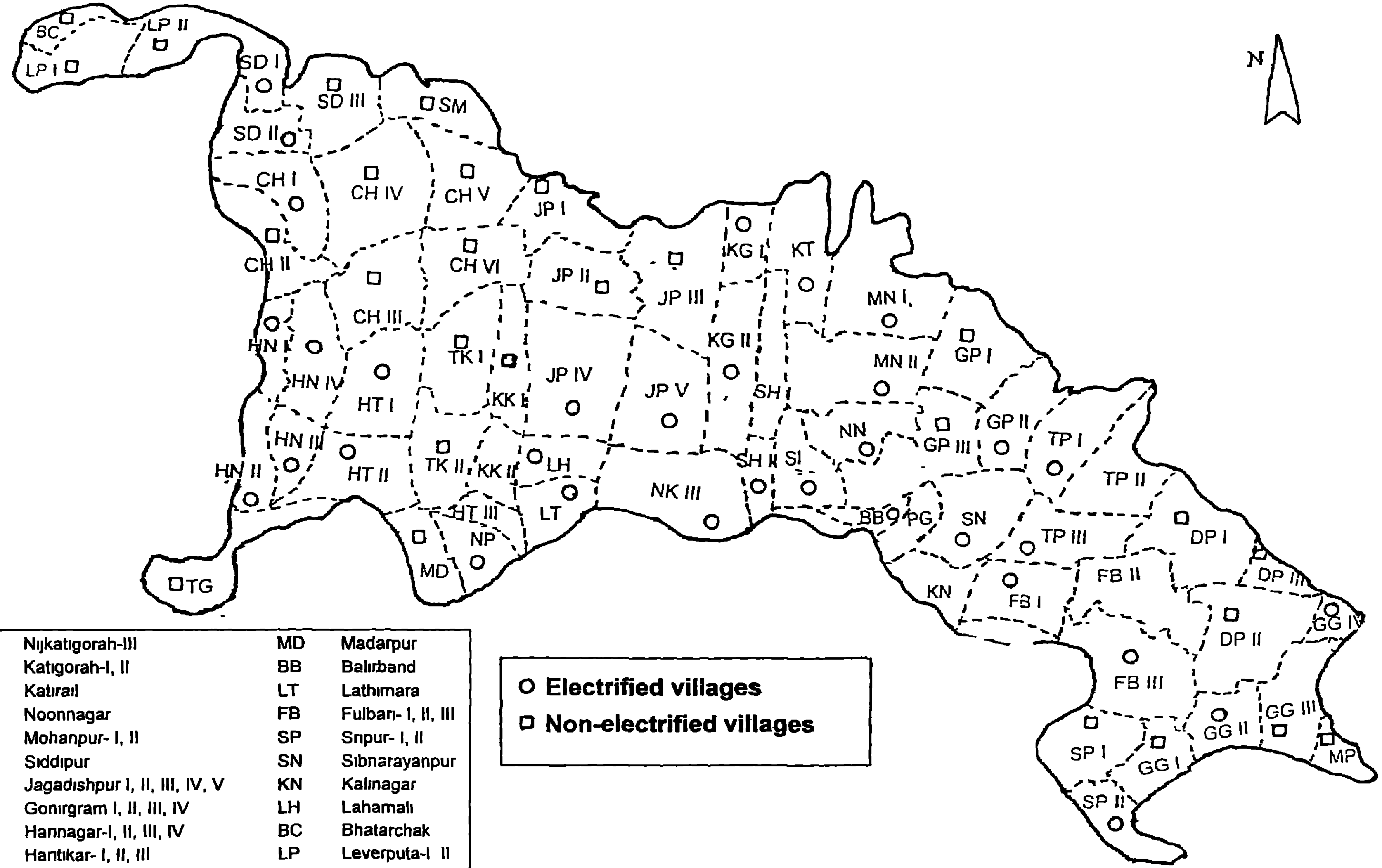
[1]Considering 20% as processing loss

Table 10.2 Potential power generation capacity

Type of biomass	Power generation potential (gasifier with duel fuel mode)		
	24 hr supply	12 hr supply	6 hr supply
Crop residue	150 61 kW	301 22 kW	602 44kW

10.2 Location of biomass based power generating units

Biomass-based power generation at the centralised level is not a practical option in light of the available surplus biomass and the large number of un-electrified villages However, in the present context, the capacity, location and distribution of biomass based power generating units will depend on the potential biomass available per day Since the surplus biomass available is only 6 77 t/day, biomass based power generation calls for decentralised applications on a smaller scale to be operated under specified periods Thus it implies that all the 33 un-electrified villages (Figure 10 1) cannot be completely electrified through gasifier systems alone Based on the current availability of surplus crop residues, there is scope for electrifying clusters of villages with select number of households can be electrified, with supply restricted to of 5-6 hours daily for lighting and small scale end-use applications. Depending on the household population of the villages, 18 gasifier systems of differing capacities of 20 kW, 30 kW and 50 kW can be installed (Table 10.3 and Figure 10 2) The biomass supply for such power generation will be sourced from the beneficiary villages and the surrounding villages



NK	Nijkatigorah-III	MD	Madarpur
KG	Katigorah-I, II	BB	Balirband
KT	Katirail	LT	Lathimara
NN	Noonnagar	FB	Fulbari- I, II, III
MN	Mohanpur- I, II	SP	Sripur- I, II
SI	Siddipur	SN	Sibnarayanpur
JP	Jagadishpur I, II, III, IV, V	KN	Kalinagar
GG	Gonirgram I, II, III, IV	LH	Lahamali
HN	Harinagar-I, II, III, IV	BC	Bhatarchak
HT	Haritikar- I, II, III	LP	Leverputa-I II
CH	Chandinagar I,II, III, IV, V, VI	SD	Saidpur-I, II, III
KK	Karaikandi- I, II	TG	Tukargram
SH	Sidheshwar-I, II	SM	Salimabad
TK	Telitikar- I, II	DP	Dudpur-I, II, III
GP	Gobindapur-I, II, III	MP	Mahadevpur
TP	Tarinipur- I, II, III	PG	Panchgram
NP	Nazatpur		

Figure 10.1 Distribution of electrified and non-electrified villages in Katigorah

Table 10.3 Distribution of potential power generation sites

Cluster	*Source of biomass supply*	*Biomass available t/y*	*Gasifier capacity, location,*	*Operating hours/day*	*Non-electrified villages and no of households*	*Villages to be electrified*
I	Bhatarchak Leverputa I Leverputa II	75 61	**20 kW** ***Leverputa I***	6-7	Bhatarchak (58) Leverputa I (120) Leverputa II (337)	Bhatarchak Leverputa I
II	Tukargram Harinagar I Harinagar II	97 551	**30 kW** ***Tukargram***	5-6	Tukargram (171)	Tukargram
III	Chandinagar I Chandinagar II Harinagar I Harinagar IV	151 49	**50 kW** ***Chandinagar II***	5-6	Chandinagar II (350)	Chandinagar II
IV	Chandinagar IV Chandinagar III Saidpur I Saidpur II Saidpur III Salimabad	149 06	**50 kW** ***Chandinagar IV***	5-6	Chandinagar IV (264) Chandinagar III (214) Saidpur III (100) Salimabad (195)	Chandinagar IV
V	Chandinagar VI* Chandinagar V Katigorah III	40 71	**20 kW** ***Chandinagar VI***		Chandinagar VI (139) Chandinagar V (20)	Chandinagar VI Chandinagar V
VI	Telitikar I * Telitikar II Haritikar II Haritikar I*	128 47	**30 kW** ***Telitikar II***	6-7	Telitikar I (69) Telitikar II (239)	Telitikar II
VII	Karaikandi II Lathimara Lahamali	121 5	**30 kW** ***Karaikandi II***	6-7	Karaikandi II (249)	Karaikandi II
VIII	Madarpur Nazatpur	117 46	**30 kW** ***Madarpur***	6-7	Madarpur (264)	Madarpur
IX	Jagdishpur I* Jagdishpur II* Jagadishpur III* Jagadishpur IV Jagadishpur V* Karaikandi I* Katigorah I Katigorah II Katirai	145 85	**50 kW** ***Jagadishpur III***	5-6	Jagadishpur I (13) Jagadishpur II (29) Jagadishpur III (73) Karaikandi I (100)	Jagadishpur I Jagadishpur II Jagadishpur III Karaikandi I

X	Siddheshwar I Siddeswar II Mohanpur II	84 39	**20 kW** ***Siddeswar I***	6-7	Siddheshwar I (52)	Siddheshwar I
Xi	Gobindapur I* Gobindapur II* Gobindapur III* Mohanpur I Noonnagar Siddipur	71 02	**20 kW** ***Gobindapur III***	5-6	Gobindapur I – 52 Gobindapur III - 385	Gobindapur III
XII	Panchgram* Kalinagar Balirbond* Shibnarayanpur* Nijfulbari I	184 40	**50 kW** ***Kalinagar***	6-7	Panchgram – 57 Kalinagar- 223	Kalinagar Panchgram
XIII	Tarinipur I Tarinipur II	61 24	**20 kW** ***Tarinipur II***	5-6	Tarinipur II (33)	Tarinipur II
XIV	Dudpur I Nijfulbari II* Tarainipur III	142 51	**50 kW** ***Dudpur I***	5-6	Dudpur I (315) Nijfulbari II (41)	Dudpur I
XV	Dudpur II Dudpur III Gonirgram IV	103 48	**30 kW** **Dudpur II**	5-6	Dudpur II (81) Dudpur III (287)	Dudpur III
XIVI	Mahadevpur Gonirgram III Gonirgram II	107 5	**30 kW** ***Gonirgram III***	5-6	Mahadevpur – 70 Gonirgram III - 367	Gonirgram III
XVII	Sripur I Sripur II	91 56	**20 kW** ***Sripur I***	6-7	Sripur (232)	Sripur
XVIII	Gonirgram I Nijfulbari III	98 49	**30 kW** ***Gonirgram I***	5-6	Gonirgram (172)	Gonirgram

Note *Biomass availability data are not available for these villages Thus the exact capacity of the gasifier may be higher than capacity mentioned above

10.3 Economics

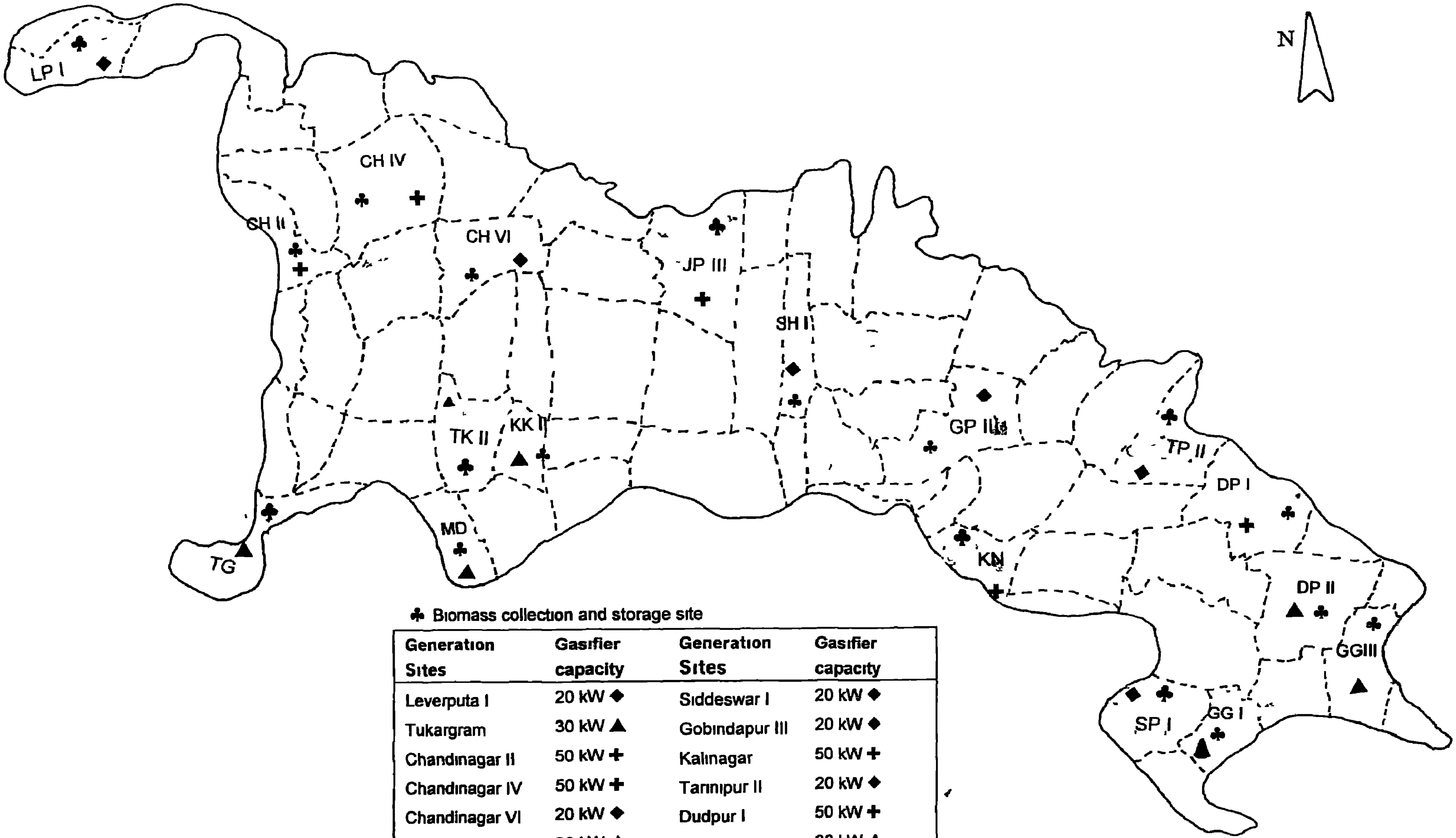
The cost of generation per kilowatt of power would depend on the capacity of the system and its application MNES provides a capital subsidy of 90% for gasifier based systems in the North Eastern Region irrespective of the capacity Therefore under the present circumstances, subsidy can be availed of for gasifier system of any capacity Financing can also be availed of, from IREDA at low interest rate, which for NE region is only 2 5 % A 50 kW capacity rice husk based gasifier operating on dual fuel mode for 6 hours daily would consume about 14 tonne crop residue and 900 litres of diesel per month (*Diesel input of 100 ml required for generating one unit of electricity)* In case of 20 kW and 30 kW gasifiers, the corresponding figures for crop residue and diesel would

be 5 4 tonne and 360 litres and 8 1 tonne and 540 litres respectively Diesel is available locally at price of Rs 17/litre Since the consumption of diesel is low, the major concern would be related to biomass As crop residue is limited, proper storage facilities with capacities for sustainable operation have to be developed It is presumed that biomass for power generation would be procured fiom the villages within the clusters identified or from neighbouring villages. Paddy husk is currently available at a price of Rs 1/kg, but there would be an additional cost added, which relates to transport The cost for biomass transport would be limited, as transportation would be mainly carried through handcart at a cost of Rs 20-30 for a load of 200 kg, within a radius of 3 to 4 km The above discussion provides information related to the total fuel cost per kWh generation, but detail cost per kWh generation would depend on the capacity of the system and the distribution network Gasification systems based on dual fuel operation are commercially available, the capacity being limited to 500 kW in the country Table 10 4 provides an approximate cost estimation for biomass based power generation under desired capacities

Table 10. 4 Cost estimation for biomass based power generation

Sl No	Capital costs		Proposed capacities		
			50 kW	30 kW	20 kW
1	Gasification unit, cooling cleaning system and instrumentation @ Rs 7500 per kW		375 000 00	225 000 00	150 000 00
2	Generating set @ Rs 4 000 – 5 000 per kW		200 000 00	150 000 00	100 000 00
3	Erection & commissioning (approx 15%-20 % of capital cost of gasifier and generator)		86 250 00	56 250 00	37 500 00
4	Cost of civil works (foundation, engine room, water supply, drainage, etc) @ Rs 2000 per kW but the cost would be about 50 % more for system less than 100 kW capacities		150 000 00	90 000 00	60 000 00
5	**Total**		**811 250 00**	**521 250 00**	**347 500 00**
6	**B Operational expenditure per month (for running 6 hours daily)**				
7	Fuel	Diesel @ Rs17 00 per litre	15 300 00	9180 00	6 120 00
		Biomass @ Rs 1 000 00/ tonne*	13 500 00	8100 00	5 400 00
8		Cost for transportation of biomass @ Rs 125 00 per tonne	1 687 50	1012 50	675 00
9	Labour	Skilled worker (1) @ Rs 4000/month	4000 00	4000 00	4000 00
		Semi skilled worker (1) @ Rs 2 000 / month	2000 00	2000 00	2000 00
10	Cost of lubrication @ Rs 250 per month		250 00	250 00	125 00
11	**Total**		**36 737 50**	**24 417 50**	**18 320 00**

Note The above estimates do not include transmission and distribution cost as the length of distribution would be variable The costs are indicative and are based on the survey of the current market prices, which are liable to change *It is also expected that the cost of biomass will reduce by at least 25%-50% when procured in bulk on a regular basis



♣ Biomass collection and storage site

Generation Sites	Gasifier capacity	Generation Sites	Gasifier capacity
Leverputa I	20 kW ◆	Siddeswar I	20 kW ◆
Tukargram	30 kW ▲	Gobindapur III	20 kW ◆
Chandinagar II	50 kW ✚	Kalinagar	50 kW ✚
Chandinagar IV	50 kW ✚	Tarinipur II	20 kW ◆
Chandinagar VI	20 kW ◆	Dudpur I	50 kW ✚
Telitikar II	30 kW ▲	Dudpur II	30 kW ▲
Karaikandi II	30 kW ▲	Gonirgram III	30 kW ▲
Madarpur	30 kW ▲	Sripur I	20 kW ◆
Jagadishpur III	50 kW ✚	Gonirgram I	30 kW ▲

Figure 10.2 Location of biomass collection centres, and potential power generating sites

Chapter 11

Recommendations and proposals

In Katigorah block, the biomass resources available are in the form of wood, agriculture residue, and animal dung The current uses of these resources are wood for cooking, space heating and small timber, dung and residues for manuring and fodder, respectively Observations on the current power supply-consumption scenario revealed that domestic sector is the major consumer, followed by commercial sector (shops, restaurants) Industrial power demand is insignificant in the absence of any large-scale industries except for small-scale units such as rice mills

The current utilization pattern of wood in the block, with the consumption exceeding the sustainable yield, leaves no scope for surplus woody biomass However, crop residues from paddy, and other minor crops constitute the primary surplus biomass in Katigorah Given the limited surplus residue availability of 2473 78 t annually and the scattered distribution of unelectrified villages, *centralised generation of power may not be practical* But **decentralised power production is a feasible alternative** for electrification of cluster of villages. This option has significance as ASEB (Assam State Electricity Board) has no immediate plans of connecting the unelectrified villages to the grid Moreover, the major consumer is the domestic sector with low power demand. The gasifiers could be installed at the biomass producing unelectrified villages. Thus, the following options are recommended for dissemination of gasifiers of power generation at decentralised level

- Gasifier capacities of **50kW, 30kW and 20 kW can be installed** depending on the biomass generation and the number of unelectrified households in a particular village Though biomass based power generation has potential in the block, the technology needs to be demonstrated on a pilot scale to convince both probable producers and consumers of the benefits of gasifier technology. Given the MNES subsidy pattern, which is available for gasifier systems of any capacity in the North Eastern region, a demonstration unit can be installed at any of unelectrified villages. This can be taken up by ASTEC, which is the renewable energy development agency for Assam, in collaboration with the local ASEB division. The ASEB could oversee the operation and maintenance of the system
- Once the credibility of the pilot system is established and the villagers convinced of the benefits of the technology, the installation of the other gasifier can follow The finances can be mobilised either through MNES subsidy or IREDA in form of soft loans Village level committees could be established to supervise the collection, transportation and processing of the biomass feedstock For operation and

maintenance of the gasifiers, local youth are to be trained and an honorarium given to them for the services rendered.

- Traders involved in the commercial sale of paddy could be persuaded to undertake supply of residues to the generating sites as they are familiar with location of the villages in the study block, and the modalities of procuring and transporting paddy.
- Though involvement of private investment is encouraged in power production, but owing to the limited scale of surplus biomass available and the potential for only low capacity of gasifiers, entrepreneurs may not be interested in such ventures in the block Hence, if initiative is taken either by ASTEC or NGOs, then only can biomass based power generation in the block will be possible.
- In the absence of any policy for private power generation in the state, permission from ASEB would have to be obtained for generation and public distribution. It is imperative for the producers to make a long-term formal agreement with local ASEB (Silchar Electrical Sub-Division) authority for power production and supply. Without such arrangement, the implementation of such endeavours may be fraught with operational difficulties.

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Annex 1 Survey schedule

Biomass Assessment for Power Generation in Katigorah Block, Cachar district, Assam

Village schedule

General information

1. Village Name ______________ 2 Geographical Area________ Ha

3 No of Households _____4 Population____ 5 Major ethnic group_________

6. Type of connecting road metalled/foot track/motorable (unmetalled)

7 Distance from

Item	Distance (km)
State/National highway	
Grid	
Bus stand	
Railway station	
Post office	
Bank	
Hospital/dispensary	
Cooperative/kerosene depot	

Electrification

8 Village Electrified (Yes/No)

If yes number of households electrified _________

9. Source of electrification Grid/Diesel Gen sets (capacity) kVA

10 No Of hours power is available (summer) ________hrs/day

11 No of hours power is available (Winters) ________hrs/day

12 Types of connections

Types	Number
Domestic	
Agriculture	
Commercial	
Industries	
Others	

13 Electricity tariff Billing/Flat rate
Average rate _______Rs/month/connection/point

Land details

14. Land Area (in bigha/ acres)

Total cropped area	
Net irrigated area	
Gross irrigated area	
Non irrigated area	
Forest land and species of trees grown	
Area not available for cultivation	
Grazing/ Fallow land	
Land under Non Agricultural uses	

15 Land ownership

Land category	Number of households
Large (> 150 bigha)	
Medium (60- 150 bigha)	
Small (15- 30 bigha)	
Marginal (< 15 bigha)	
Landless	

16 Crops Grown

Crops grown	Area (Bigha)	Yield (Mon/Bigha)	Total production (Mon/year)	Type of Agri residue	Crop - residue ratio	Total residue Qtl/year
				1 2.		
				1 2		
				1 2		
				1 2		
				1 2		
				1 2		
				1 2		

17 Livestock details

Cow	Bullock	Buffalow	Goat	Pigs	Poultry	Others

18 Total Dung __________Kg per day   Use of dung ____________

19 Drinking water details

Source	Numbers	Distance (km)
Handpump		
Wells		
Taps		
Tubewell		
Stream		
Tank		
Others		

20 Irrigation details

No of canals Govt & Private	
Area irrigated by canal (bigha)	
No of tanks	
Area irrigated by tanks (bigha)	
No of wells	
Area irrigated by wells (bigha)	
No of Borewells	
Area irrigated by borewells (bigha)	
No of lift irrigation projects	
Area irrigated by lift irrigation (bigha)	
Other sources – Name	
Area irrigated by other sources (bigha)	

Energy

21 Energy sources

Fuel	End use	Source	Price (Rs)	Distance (km)
Firewood				
Animal dung				
Crop residues				
Kerosene				
Diesel				
LPG				
Coal				
Others				

22. Small industries

Industry	Number	Capacity (HP)	Raw material (Mon)	Waste generated (Mon)
Flour mill				
Rice mill				
Saw mill				
Others				

23 Collection of wood

Season of collection	Source	Access (right to) for

Access fuel/fodder/small timber/timber

Biomass utilisation

24 Availbility of biomass

Is biomass available?	Yes/No
Whether household sell biomass	Yes/No
To whom and at what rate?	
No of times HH sell biomass per year	
Place of storage	
Transportation arrangement	
Cost of transport	

25 Utilisatuon of biomass

Crop	Crop residue	Biomass utilisation Mon/year					Total Mon/year
		Fuel	Fodder	Roofing	Fertilizer	Others	
	1 2						
	1 2						
	1 2						
	1 2						

Additional Remarks (if any)

Biomass Assessment for Power Generation in Katigorah Block, Cachar district, Assam

Household Level Schedule

Village____________

I Household details

1 Head of the household____________________ 2 Respondent Name ______________

3. Family details

	Number	Education level	Occupation	
			Primary	Secondary
Men				
Women				
Children (< 15 yr)				

4 House type

- Construction material. bamboo/thatch/tin/cement No of rooms Pucca
- Electrified Yes/No Kuchha

5. Land Ownership details

Item	Acres/ bighas	Lease	
		Given	Taken
Total land			
Agricultural land			
Irrigated land			
Unirrigated land			
Fallow land			
Garden/orchard			
Forest land			
Others			

6 Livestock details

Cow	Bullock	Buffalow	Goat	Pigs	Poultry	Others

7 Total Dung _________Kg per day Use of dung. ____________

II Biomass availability and Utilisation

8 Crops Grown

Crops grown	Area (Bigha)	Yield (Mon/Bigha)	Total production (Mon/year)	Type of residue	Crop - residue ratio	Total residue Mon/year
				1 2		
				1 2		
				1 2		
				1 2		
				1 2		
				1 2		

9 Availability of biomass and utilization

Biomass →				
Biomass cannot be collected (in Mon)				
Whether household sell biomass				
Rate of biomass (Rs/mon)				
Place of storage				
Period of storage (no of months)				
End uses				

10 Utilization of biomass

Crop residue	Total prod Mon/year	Biomass utilization (Mon/year)							
		Fuel	Fodder	Roofing	Fertilizer	Given free	Sold	Burnt	Left at the field

10 Sale of Biomass

Biomass	Where sold	To whom sold	Rate	When sold	Transport		Distance	End use
					own	Buyer's		

III Fuel consumption

11 Fuel consumption

Fuel	Unit	Cooking	Water heating	Space heating	Lighting	Others	Season wise utilization (in % age)		
							Summer	Monsoon	Winter
Firewood	Kg/day								
Kerosene	lit/month								
Crop residue	Kg /day								
Cow dung	Kg/day								
Coal	kg/month								
LPG	cylinder/month								
Diesel	lit/month								
Electricity	Units								
Biogas									
Others									

12 Fuel source and availability

Fuel type	Source	Qty	Easily available	Free of cost	Cheapest	Alternative not available	Cannot buy	Preference (rank)
Firewood								
Kerosene								
Crop residue								
Cow dung								
Coal								
LPG								
Diesel								
Electricity								
Biogas								
Others								

13. Device ownership

End use	Device type	Numbers	How many are used simultaneously	Hours used/ day
Cooking	• Traditional stove • Improved stove • Kerosene stove (Wick/pressurized) • LPG stove • Biogas stove	-		
Lighting	• Kerosene wick lamp • Kerosene lantern			

End use	Device type	Numbers	How many are used simultaneously	Hours used/ day
	• Solar lantern • Petromax • LPG petromax • Bulb/Tube (give wattage and hrs of use of each bulb per day)			
Space Heating	• Electric heaters • Traditional stove			
Other assests	• Radio/Tape recorder • Television • Scooter/Motor bike • Cycle • Thresher • Tractor • Diesel generator • Flour mill • Others			

14 **Electricity bill** _______________Rs/month

IV Economic status

15 **Income range**

Less than Rs 1000/-	
Between Rs 1000/- and Rs 5000/-	
Between Rs 5000/- and Rs 10000/-	
More than 10000/-	

16 **Total household expenditure** (Rs/month)------------------------

17 **Any other observation by the surveyor**

Biomass Assessment Study in Katigorah block, Cachar district, Assam

SURVEY SHEET FOR COMMERCIAL ESTABLISHMENTS

(*Hotels, Lodges, Guest houses, Institutions*) Sheet No ______

A. General information

1. Category of establishment (tick) Hotel/ Lodge/Guest house/Hostel/IB/CH
2. Name of establishment ___________ Respondent's name ____________
   Years of functioning ____ No of rooms____kitchen/laundry/offices (tick)
3. Electricity supply Summers ______hrs/dy Winters_______hrs/dy
4. Average monthly electricity bill _____Cost of electricity unit __________

B. Lighting load

1. Electricity

No of bulbs __________ No of tubes _________Wattage ___________

Other lighting devices _____________

2 *Non electric lighting sources*

Petromax (nos) ____________ LPG Petromax (nos) ___________

3 *Space heating (only lodging area)*

No of months of space heating _____________

APPLIANCE USED FOR SPACE HEATING

Type of appliance	Rooms	Kitchen	Restaurant	Others (specify)
Electric heater _____W)				
Blower (___W)				
Wooden Bukhari				
Coal Bukhari				
Any other				

APPLIANCE USED FOR WATER HEATING

Type of appliance	Capacity (liters)	Total Nos
Fuel wood		
Boiler (______)		
Geyser (_____W)		
Immersion rod		
Solar heating		

4 Cooking

Type of appliance	Numbers
Toaster (____W)	
Chulha	
Kerosene stove (wick)	
Kerosene stove (pressurized)	

5 Other devices

Devices	Number
Television (____W)	
Music system (____W)	
Refrigerator	
Any other	

C Have you got any generator (Diesel/Kerosene/Petrol) (tick)?

Parameter	
Total generating capacity (kW/kVA)	
Average daily utilisation (hrs)	
Consumption of fuel per hour (liters)	

D. Energy consumption pattern

Fuel type	Physical unit	Total Consumption (in physical units)	Total monthly expenditure (Rs)
LPG	Cylinders/month		
Kerosene	liters/month		
Firewood	kgs/month		
Coal/Charcoal	kgs/month		
Diesel/petrol	liters/month		
Others			

P-Peak season, S-Slack season

Hot water requirement Peak· _______lts/day or room

Slack ______lts/day or room

Biomass Assessment Study in Katigorah block, Cachar district, Assam

SURVEY SHEET FOR COMMERCIAL ESTABLISHMENTS

(Shops & restaurants) Sheet No ________

A. General information

Business type__________________ Respondent's name___________

Number of employees' ____________ Business season (specify months) _____

B. Electrification details

1 Electrical appliances and their usage

SN	Type of appliance	Total nos	Watts	Average hrs used daily
A	LIGHTING			
1	Bulbs			
2	Tubes			
3	CFL			
B	SPACE HEATING			
1	Electric heater			
2				
C	WATER HEATING			
1	Boiler			
2	Geyser			
3	Immersion rod			

1 Supply of electricity Summer _______hrs/day winter ________hrs/day

Cost of electricity unit ___________

C. Other power sources

1 Non electrical appliances and their usage

Activitiy	Type of appliance	Total Nos	Hours of usage daily
LIGHTING	Kerosene wick lamp		
	Kerosene Hurricane lantern		
	Petromax		
	Solar lantern		
	Battery lamp		
	LPG petromax		
SPACE HEATING	Wood stove		
	Open fire place		
WATER HEATING	Chulha		

Activitiy	Type of appliance	Total Nos	Hours of usage daily
COOKING	Chulha		
	Kerosene stove (wick)		
	Kerosene stove (pressurized)		
	LPG		

2. Have you got any generator (Diesel/Kerosene/Petrol) (tick)? Yes / No

SN	Parameter	
1	Number of gensets	
2	Total generating capacity (kW/kVA)	
3	Average daily utilisation (hrs)	
4	Consumption of fuel per hour (litres)	

D. Energy consumption pattern

Fuel type	Physical unit	Source	Mode of transport with distance	Total Consumption	Total expenditure (Rs)
LPG	Cylinders/m				
Kerosene	Liters/month				
Firewood	kgs/month				
Coal/ Charcoal	kgs/month				
Diesel	litre/month				
Petrol	litre/month				
Others					

Has the price of firewood increased/decresed in the last two years If so by how much ?

Rs /KG/tractor troley/trade

E. Power requirements (for lighting only)

1 How many additional light points do you need

2 How many additional hours of supply are required?

Peak season __________hrs/day Slack season ____________hrs/day

Biomass Assessment Study in Katigorah block, Cachar district, Assam

SURVEY SHEET FOR INDUSTRY

1 Type of industry______________ 2 Respondent ________________
(Establishment Year)

3 Address

Plot No	Village/Town	Taluka	Distt

4 Description of activity

Round the year	If, Seasonal (month)	Annual turnover (Rs)	Raw material		Product manufactured
			Type	Source	

5 Energy used in manufacturing & its source

Human labour		Type of energy source					
No of persons	No of hr per day	Elec	Coal	Fire wood	Agri waste	Diesel	Other (Pl sp)

6 Energy supply & expenditure

Type of energy	Purchase		Expenditure/Cost				
	Qty	Source	Basic	Cartage	Handling	Taxes	Stores

7 Energy demand & its application

Energy	Requirement		Application	Type of firing*	Alternative fuel	
	Year	Day			Qty	Cost

*Stationary Stoker, Fluidized bed and others

8 Electricity and alternative fuel

Sanctioned load	Peak demand	Monthly consumption	Hrs of operation	Capacity of D G set	Monthly operated (hrs)	Consumption	Total

9 Details of Biomass (as fuel)

Type	Qty	Use direct/briquetting, cutting, shredding	Storage			
			For days	For months	Qty	Place

10 Reasons for using this fuel

Type of fuel	Easily available	Free of cost	Cheap estb	Can't afford other fuel	No other fuel available	Other reason (Pl Sp)

11 Future plan · Expansion Energy supply

12 By product (Biomass) and its utilisation

By-product	Quantity (Ton/year)	Consumption (ton)			Enduse
		Self	Sold	Free	

13 Details on sold by product

Rate/ ton	Distance	Mode of transport	Rate/trip